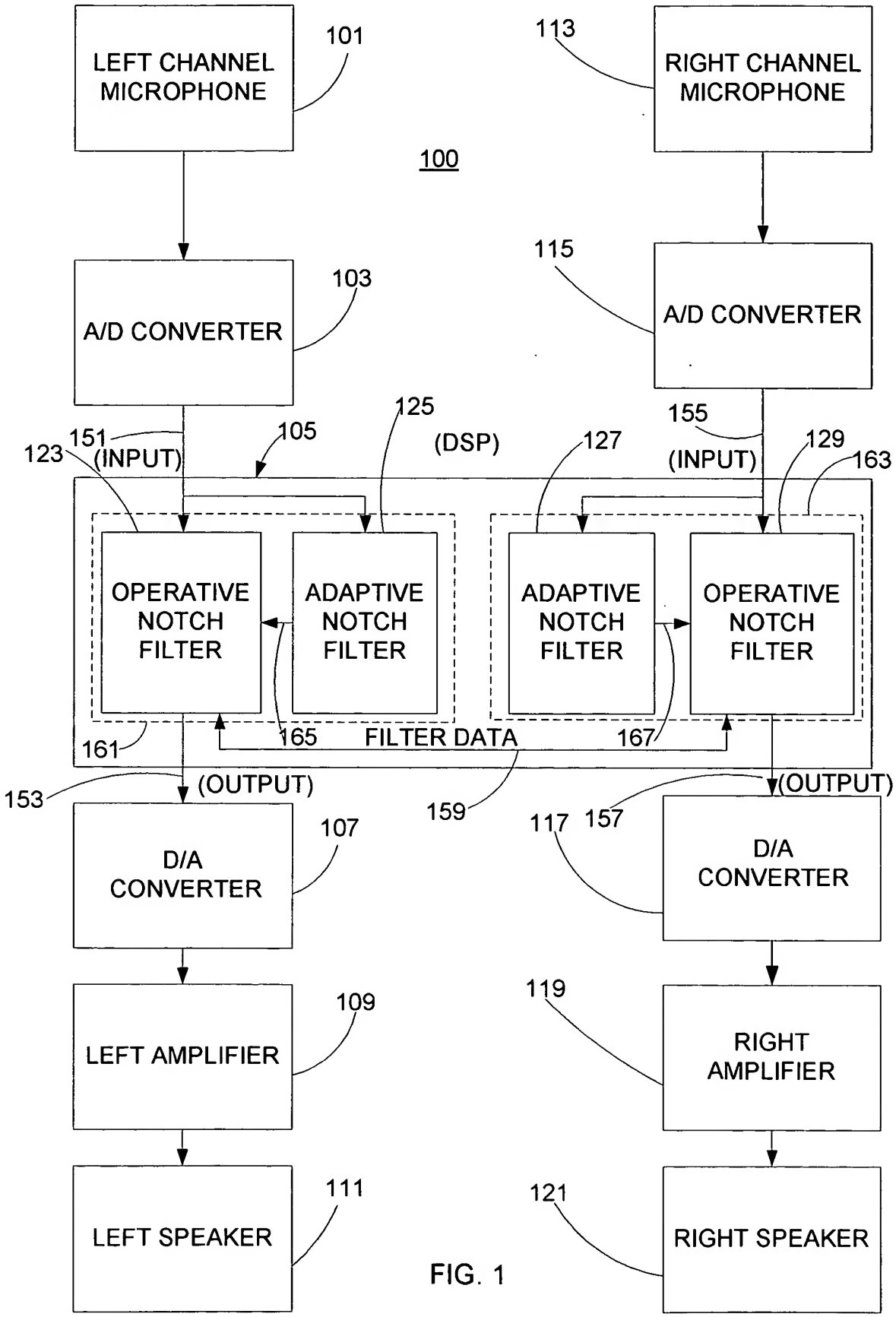
LEFT CHANNEL MICROPHONE
101
RIGHT CHANNEL MICROPHONE
113
100
A/D CONVERTER
103
A/D CONVERTER
115
125
105
(DSP)
151
(INPUT)
123
127
155
(INPUT)
129
163
OPERATIVE NOTCH FILTER
ADAPTIVE NOTCH FILTER
ADAPTIVE NOTCH FILTER
OPERATIVE NOTCH FILTER
161
165
FILTER DATA
167
153
(OUTPUT)
159
(OUTPUT)
117
157
D/A CONVERTER
107
D/A CONVERTER
LEFT AMPLIFIER
109
119
RIGHT AMPLIFIER
LEFT SPEAKER
111
121
RIGHT SPEAKER

FIG. 1

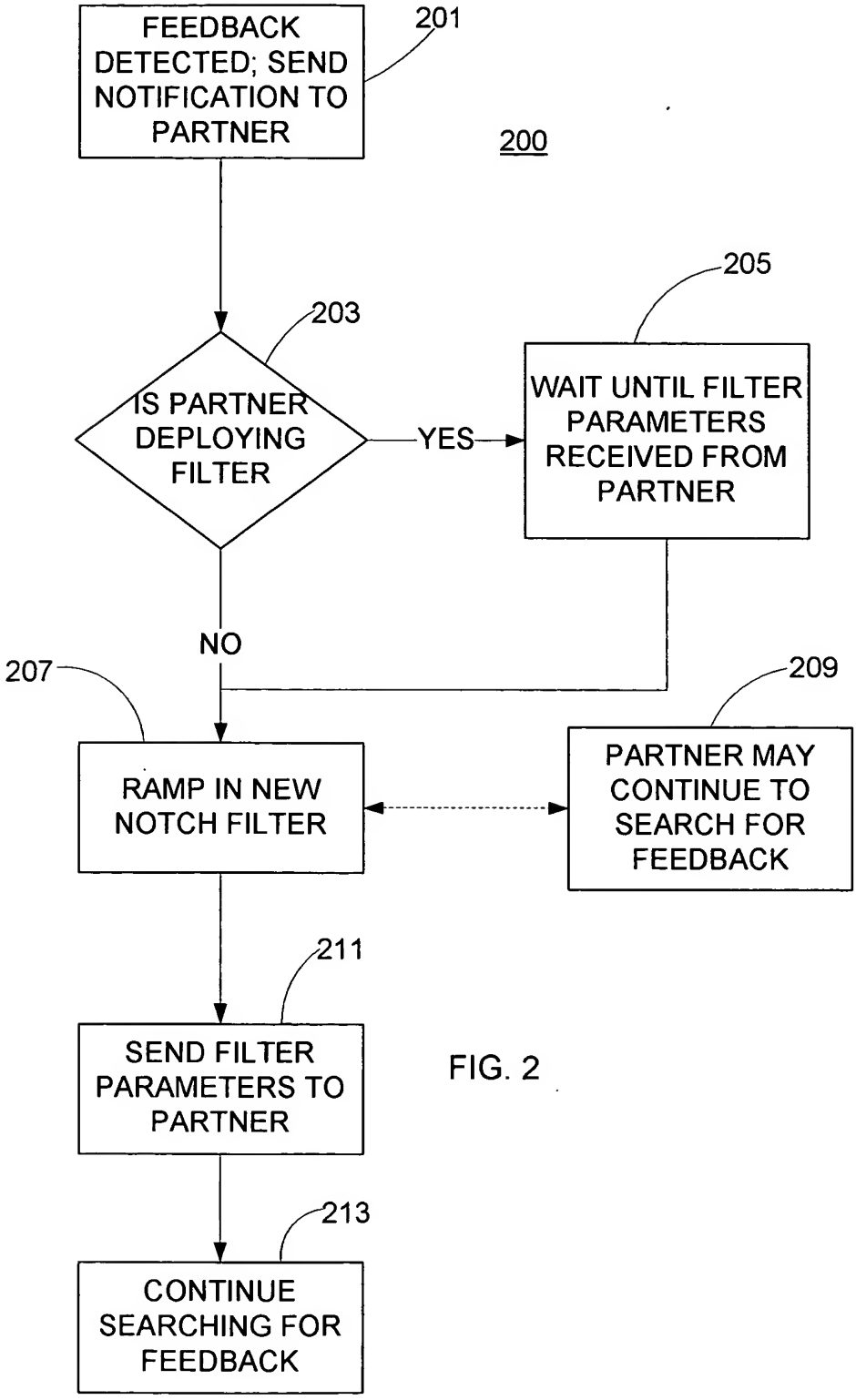
FEEDBACK DETECTED; SEND NOTIFICATION TO PARTNER
201
200
205
203
IS PARTNER DEPLOYING FILTER
YES
WAIT UNTIL FILTER PARAMETERS RECEIVED FROM PARTNER
NO
207
209
RAMP IN NEW NOTCH FILTER
PARTNER MAY CONTINUE TO SEARCH FOR FEEDBACK
211
SEND FILTER PARAMETERS TO PARTNER
213
CONTINUE SEARCHING FOR FEEDBACK

FIG. 2

	323	325	327	329
	EXEMPLARY EVENT SCENARIO			
	TIME DURATION	**EVENT**	**LEFT DFR**	**RIGHT DFR**
301	1		DETECTOR RUNNING	DETECTOR RUNNING
303	2	FEEDBACK DETECTED ON RIGHT CHANNEL	DETECTOR RUNNING	SEND SEMAPHORE
305	3		RECEIVE SEMAPHORE	EITHER DEEPEN EXISTING NOTCH OR CREATE NEW FILTER
307	4		DETECTOR RUNNING	RAMP NOTCH FILTER
309	5	FEEDBACK DETECTED ON LEFT CHANNEL	SEND SEMAPHORE	CONTINUE RAMPING FILTER
311	6		WAIT	SEND FILTER PARAMETERS
313	7		CONFIGURE NOTCH FILTER ACCORDING TO RECEIVED PARAMETERS	DETECTOR RUNNING
315	8		DEPLOY NOTCH FILTER	DETECTOR RUNNING
317	9		SEND FILTER PARAMETERS	DETECTOR RUNNING
319	10			CONFIGURE NOTCH FILTER ACCORDING TO RECEIVED PARAMETERS
321	11		DETECTOR RUNNING	DETECTOR RUNNING

300

FIG. 3

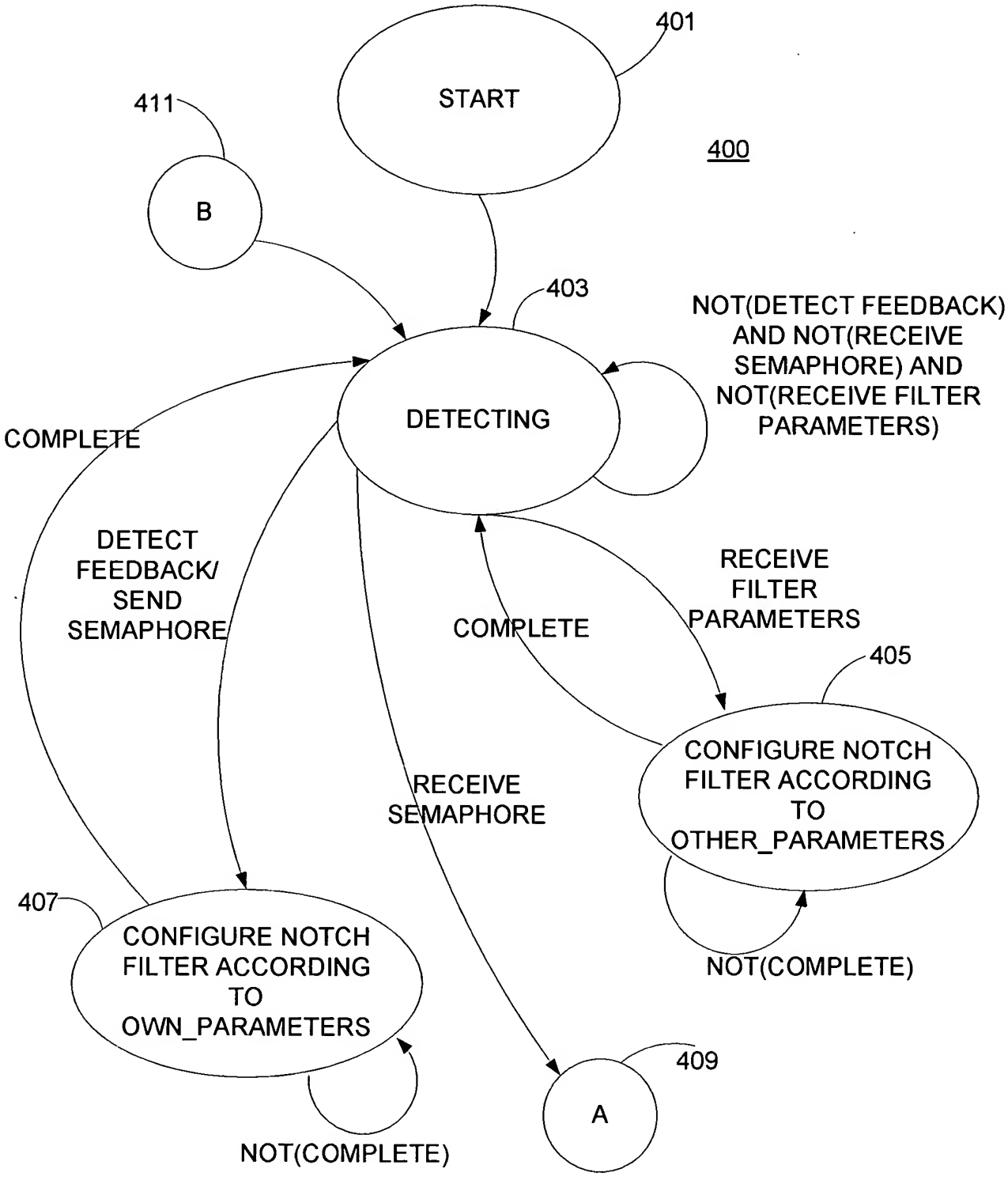
401
START
400
411
B
403
NOT(DETECT FEEDBACK) AND NOT(RECEIVE SEMAPHORE) AND NOT(RECEIVE FILTER PARAMETERS)
DETECTING
COMPLETE
DETECT FEEDBACK/ SEND SEMAPHORE
COMPLETE
RECEIVE FILTER PARAMETERS
405
CONFIGURE NOTCH FILTER ACCORDING TO OTHER_PARAMETERS
RECEIVE SEMAPHORE
NOT(COMPLETE)
407
CONFIGURE NOTCH FILTER ACCORDING TO OWN_PARAMETERS
NOT(COMPLETE)
409
A

FIG. 4

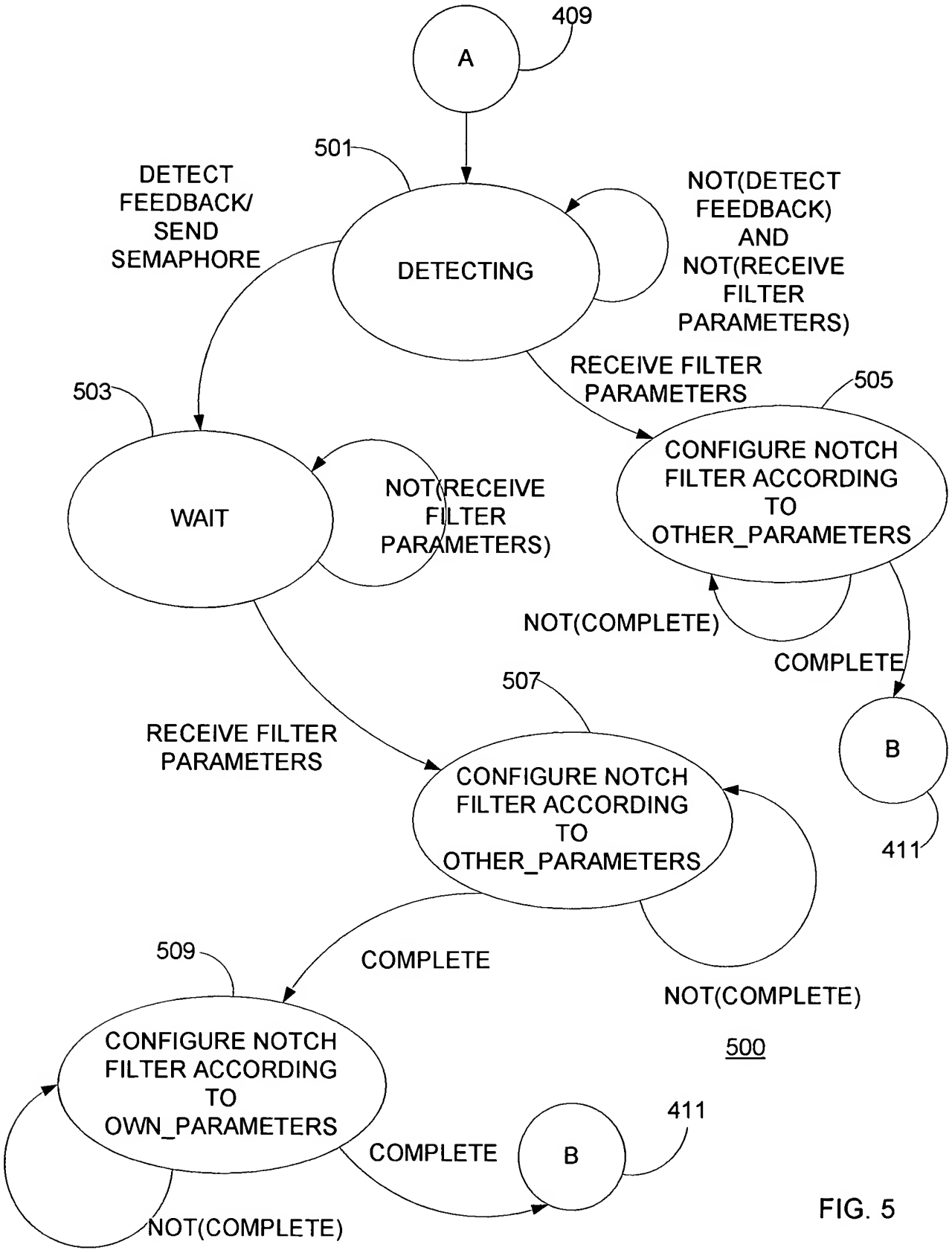
A
409
501
DETECT FEEDBACK/ SEND SEMAPHORE
DETECTING
NOT(DETECT FEEDBACK) AND NOT(RECEIVE FILTER PARAMETERS)
RECEIVE FILTER PARAMETERS
505
503
WAIT
NOT(RECEIVE FILTER PARAMETERS)
CONFIGURE NOTCH FILTER ACCORDING TO OTHER_PARAMETERS
NOT(COMPLETE)
COMPLETE
507
RECEIVE FILTER PARAMETERS
B
CONFIGURE NOTCH FILTER ACCORDING TO OTHER_PARAMETERS
411
509
COMPLETE
NOT(COMPLETE)
500
CONFIGURE NOTCH FILTER ACCORDING TO OWN_PARAMETERS
411
COMPLETE
B
NOT(COMPLETE)

FIG. 5

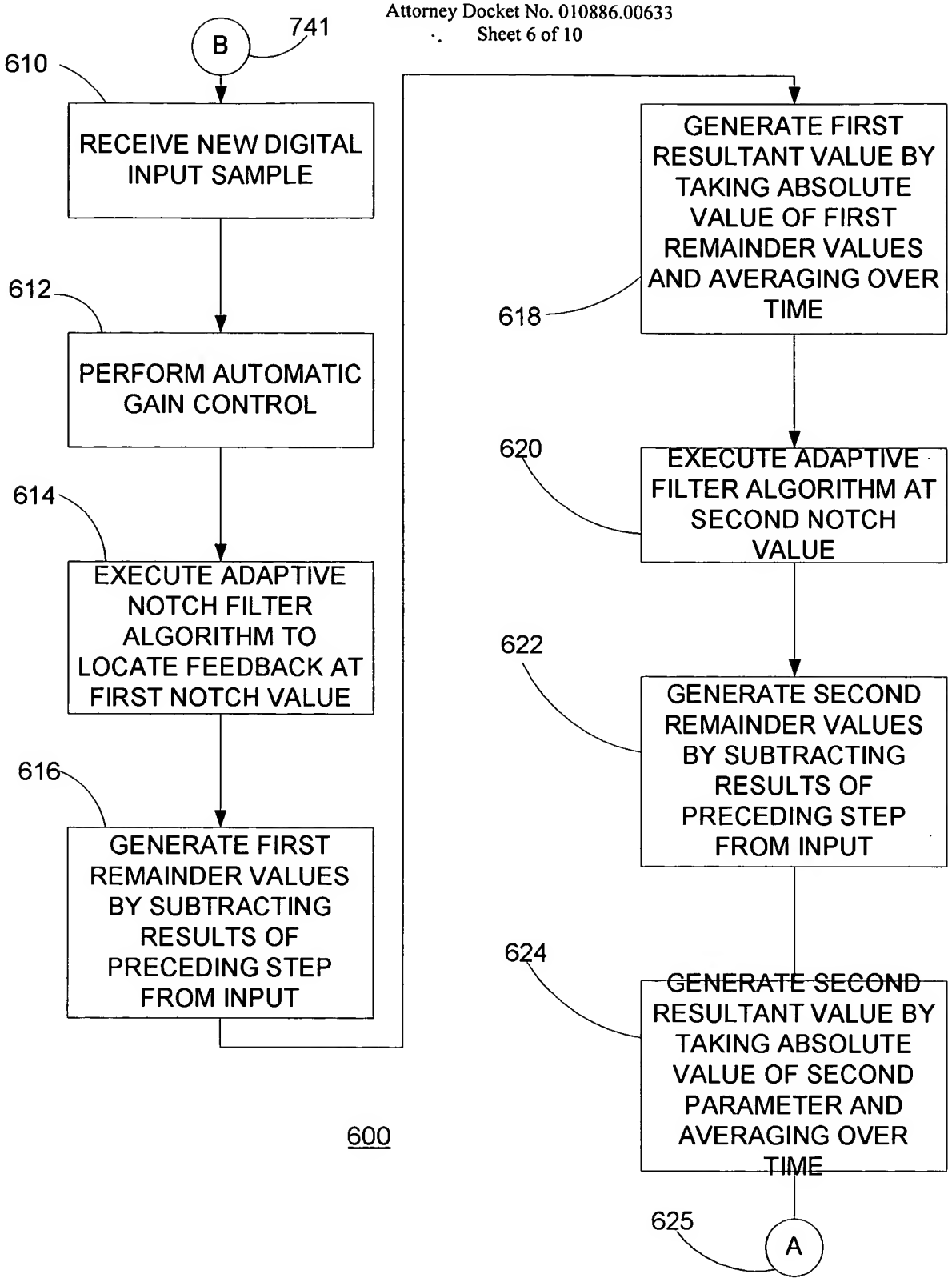
B
741
610
RECEIVE NEW DIGITAL INPUT SAMPLE
612
PERFORM AUTOMATIC GAIN CONTROL
614
EXECUTE ADAPTIVE NOTCH FILTER ALGORITHM TO LOCATE FEEDBACK AT FIRST NOTCH VALUE
616
GENERATE FIRST REMAINDER VALUES BY SUBTRACTING RESULTS OF PRECEDING STEP FROM INPUT
618
GENERATE FIRST RESULTANT VALUE BY TAKING ABSOLUTE VALUE OF FIRST REMAINDER VALUES AND AVERAGING OVER TIME
620
EXECUTE ADAPTIVE FILTER ALGORITHM AT SECOND NOTCH VALUE
622
GENERATE SECOND REMAINDER VALUES BY SUBTRACTING RESULTS OF PRECEDING STEP FROM INPUT
624
GENERATE SECOND RESULTANT VALUE BY TAKING ABSOLUTE VALUE OF SECOND PARAMETER AND AVERAGING OVER TIME
625
A
600

FIG. 6

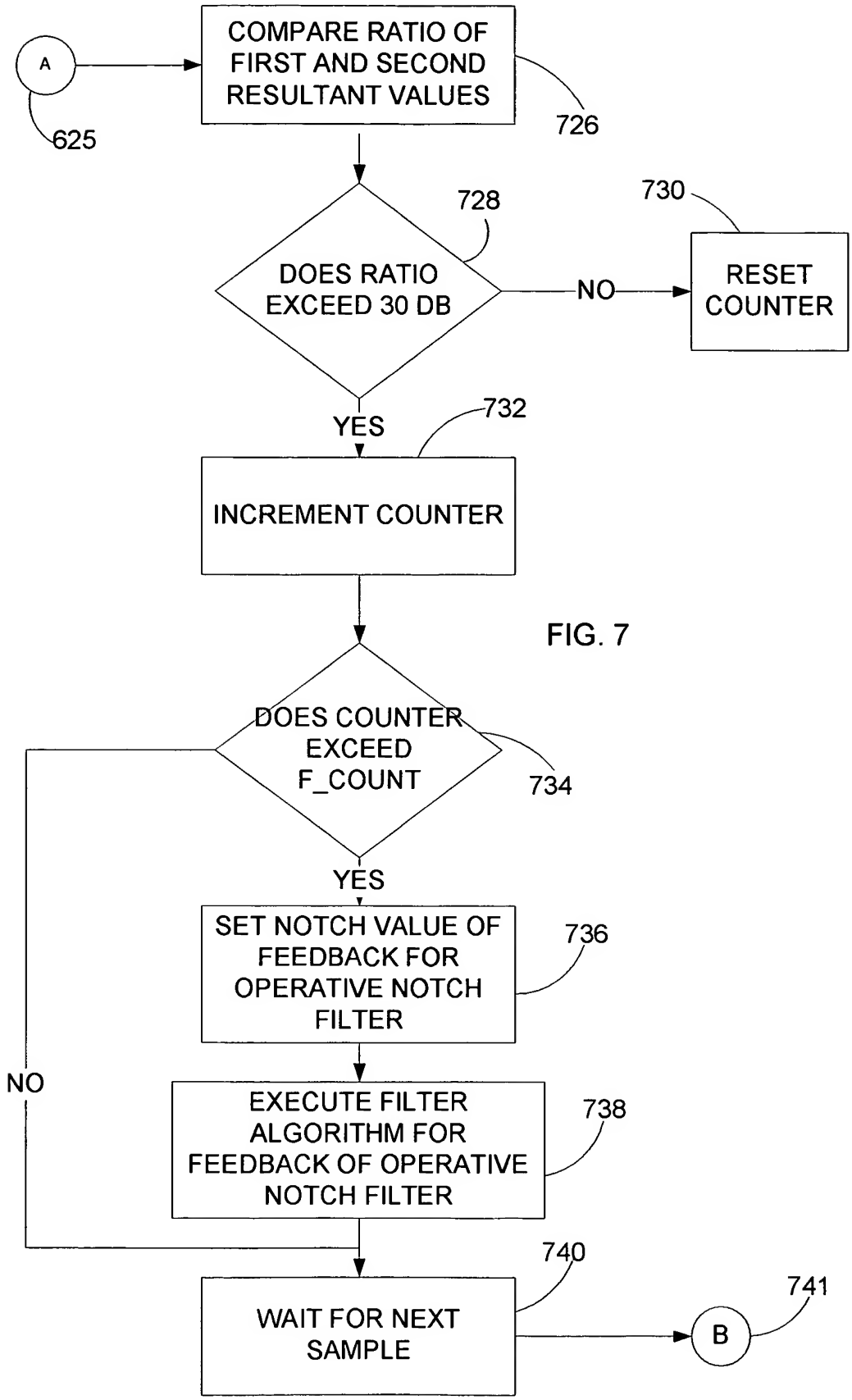
A
625
COMPARE RATIO OF FIRST AND SECOND RESULTANT VALUES
726
728
DOES RATIO EXCEED 30 DB
NO
730
RESET COUNTER
YES
732
INCREMENT COUNTER
DOES COUNTER EXCEED F_COUNT
734
YES
SET NOTCH VALUE OF FEEDBACK FOR OPERATIVE NOTCH FILTER
736
NO
EXECUTE FILTER ALGORITHM FOR FEEDBACK OF OPERATIVE NOTCH FILTER
738
740
WAIT FOR NEXT SAMPLE
741
B

FIG. 7

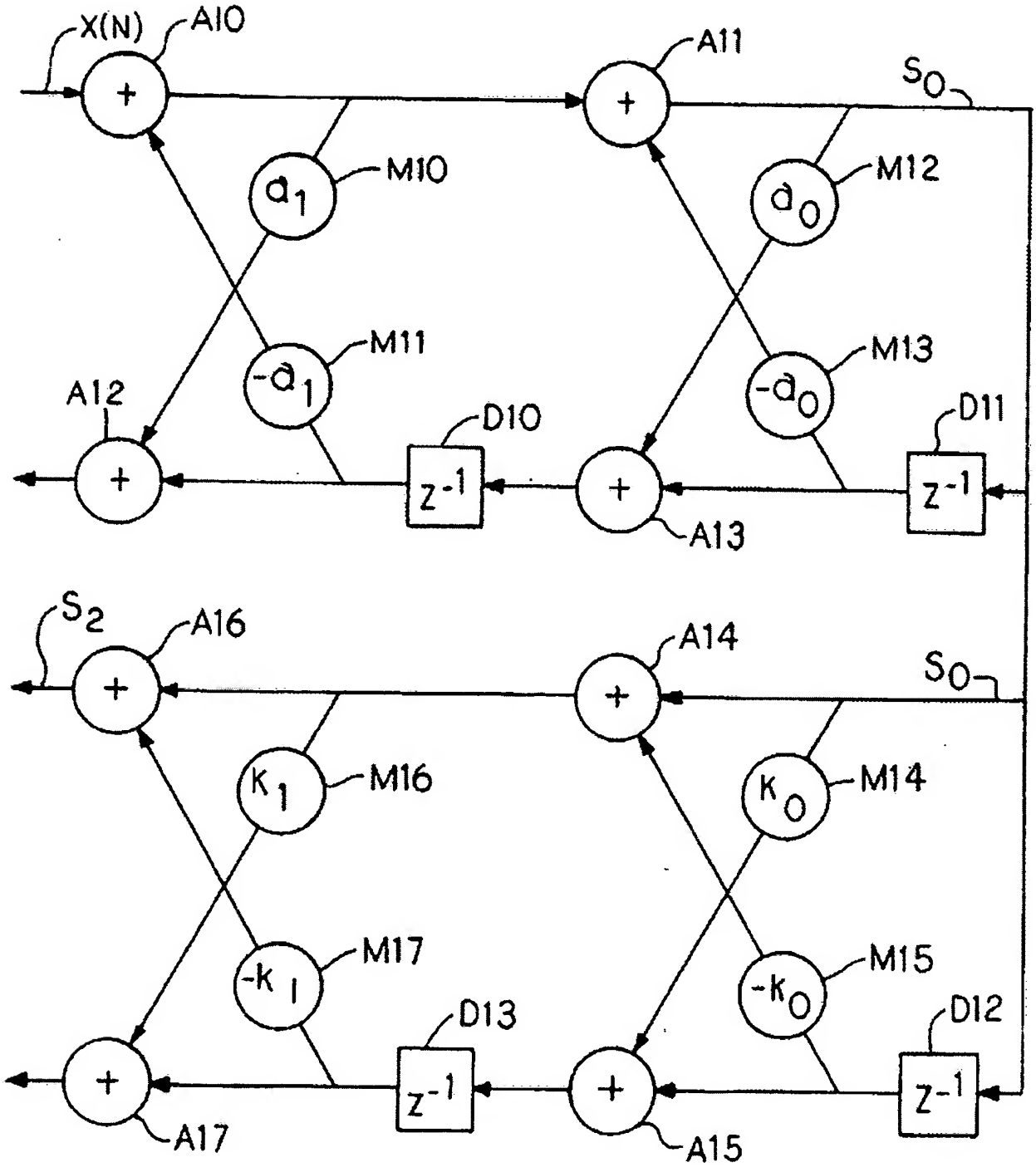
X(N)
A10
A11
S0
M10
M12
a1
a0
M11
M13
-a1
-a0
A12
D10
D11
z-1
z-1
A13
S2
A16
A14
S0
M16
M14
k1
k0
M17
M15
-k1
-k0
D13
D12
z-1
z-1
A17
A15

FIG. 8

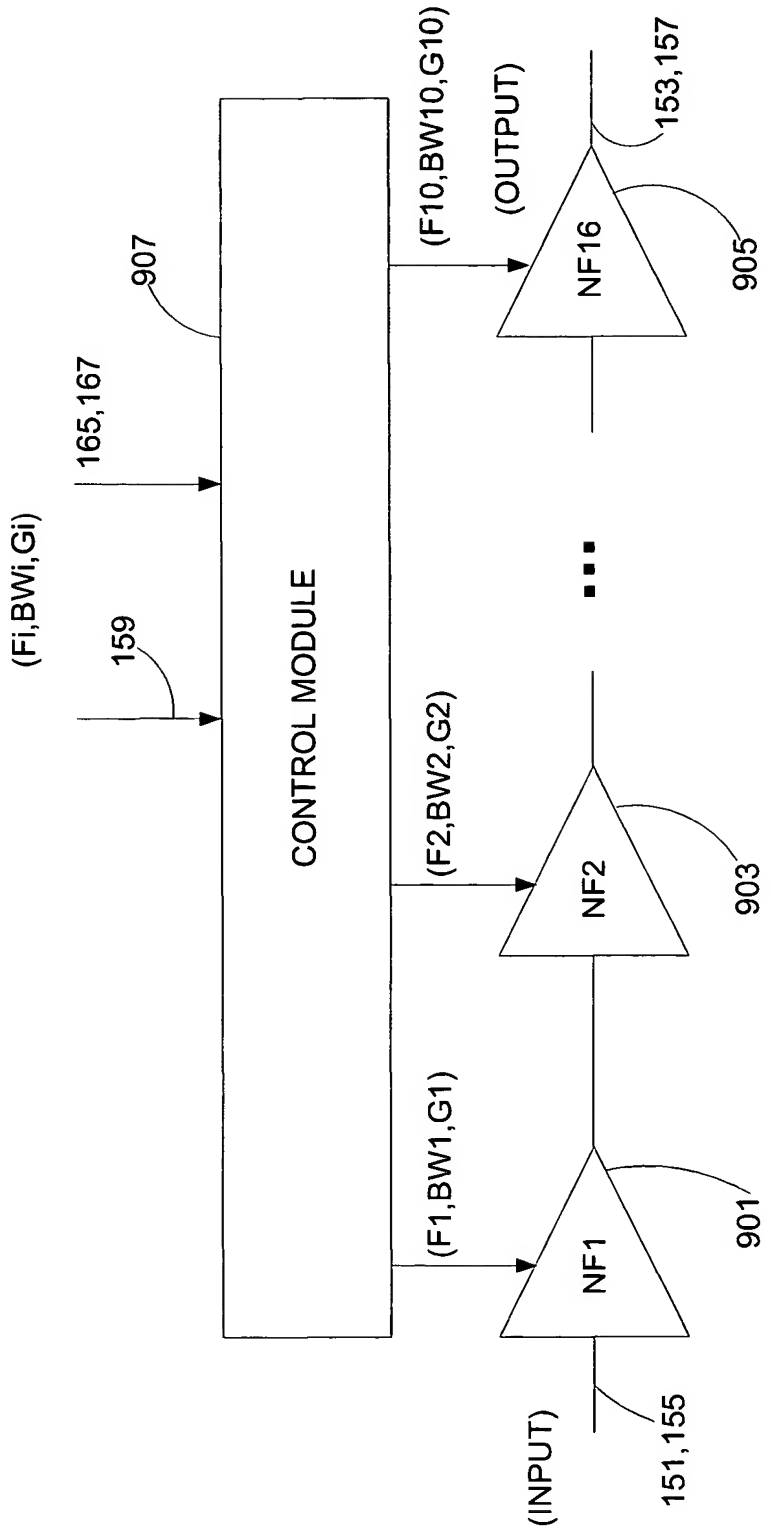
(Fi,BWi,Gi)
165,167
159
907
CONTROL MODULE
(F10,BW10,G10)
(F2,BW2,G2)
(F1,BW1,G1)
(OUTPUT)
(INPUT)
NF16
NF2
NF1
153,157
905
903
901
151,155
900

FIG. 9

1001

EXEMPLARY PERFORMANCE DATA OF A DUAL-CHANNEL DFR						
	1003 Trial 1		1005 Trial 2		1007 Trial 3	
1009 Freq.	Single CH	1011 Dual CH	1013 Single CH	1015 Dual CH	1017 Single CH	1019 Dual CH
100	2.313	1.816	2.866	1.862	3.197	3.022
200	3.050	2.292	2.826	1.813	3.019	2.067
400	2.018	1.602	1.795	1.361	1.911	1.279
800	1.757	1.259	1.716	1.359	1.710	1.215
1600	1.785	1.215	1.610	1.358	1.727	1.349
3200	1.757	1.359	1.661	1.299	1.661	1.334
6400	1.713	1.223	1.566	1.260	1.656	1.158
12800	1.627	1.332	1.682	1.308	1.634	1.309
1021 AVERAGE	2.003	1.512	1.965	1.453	2.064	1.592
1023 AVERAGE (SINGLE CH): 2.011 seconds						
1025 AVERAGE (DUAL CH): 1.519 seconds						

1000

FIG. 10